Dairy Products

Module 2
Dairy Technology

ABC Food Safety Online

Dairy Products: Module 2 – Dairy Technology

Aim

This module will provide delegates with an overview of the most important pieces of equipment used in the processing of milk**.**

Objectives

Following completion of this module, delegates will be able to:

- Identify the main pieces of equipment used in the dairy industry.

- Describe the functions of these pieces of equipment.

References

Please note that a number of diagrams used in this module are reproduced with kind permission of Professor Doug Goff, University of Guelph.

Module Description

Section	Title	Estimated time for completion*
1	Introduction	20 minutes
2	Heat Exchangers	20 minutes
3	Pasteurisation plant	30 minutes
4	Homogenisation	10 minutes
5	Separation	10 minutes
6	Glass bottle production	20 minutes
7	Carton production	20 minutes
8	Other dairy equipment	10 minutes
	Quiz	10 minutes
	Total	2.5 Hours

* Please note that this figure is provided to help plan your training. The actual time spent on each section may vary depending on your prior knowledge of the topic area.

User Hints

To complete this module, simply read through the on-screen text, click on the links for further information and make notes in this handbook where appropriate. It is recommended that you place these notes in a ring-binder and print out any additional notes from the course as required.

Remember to click on “next page” to progress through the course whenever it appears in orange text at the bottom right of the screen. If this is not highlighted then click on “next section”.

To leave and return to a course simply bookmark the page that you are using, logout and then click on the bookmark when you are ready to return to the course.

If you would like to undertake some further reading on this topic, click on the “library” button to view links to legislation, codes of practice etc.

Section 1 - Introduction

The dairy industry is responsible for the manufacture of a diverse range of products and so the technology used by a manufacturer will vary depending both on the product and the volumes produced. However, there are a number of pieces of equipment which are common throughout the dairy industry and these will be reviewed further in this module.

Milking technology

The milking process on a modern dairy farm comprises the following main elements:

Cleaning/disinfection of teat

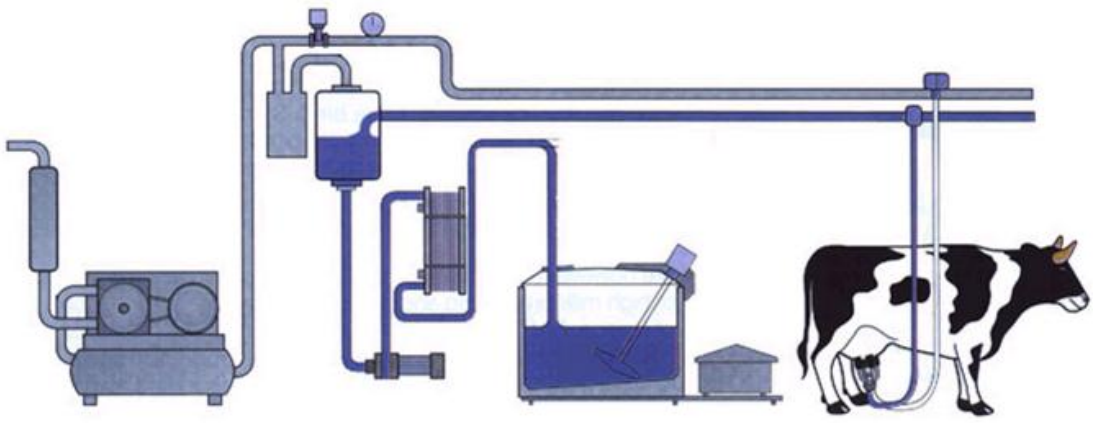
Drawing of foremilk

Automated milking

Heat exchange

Storage

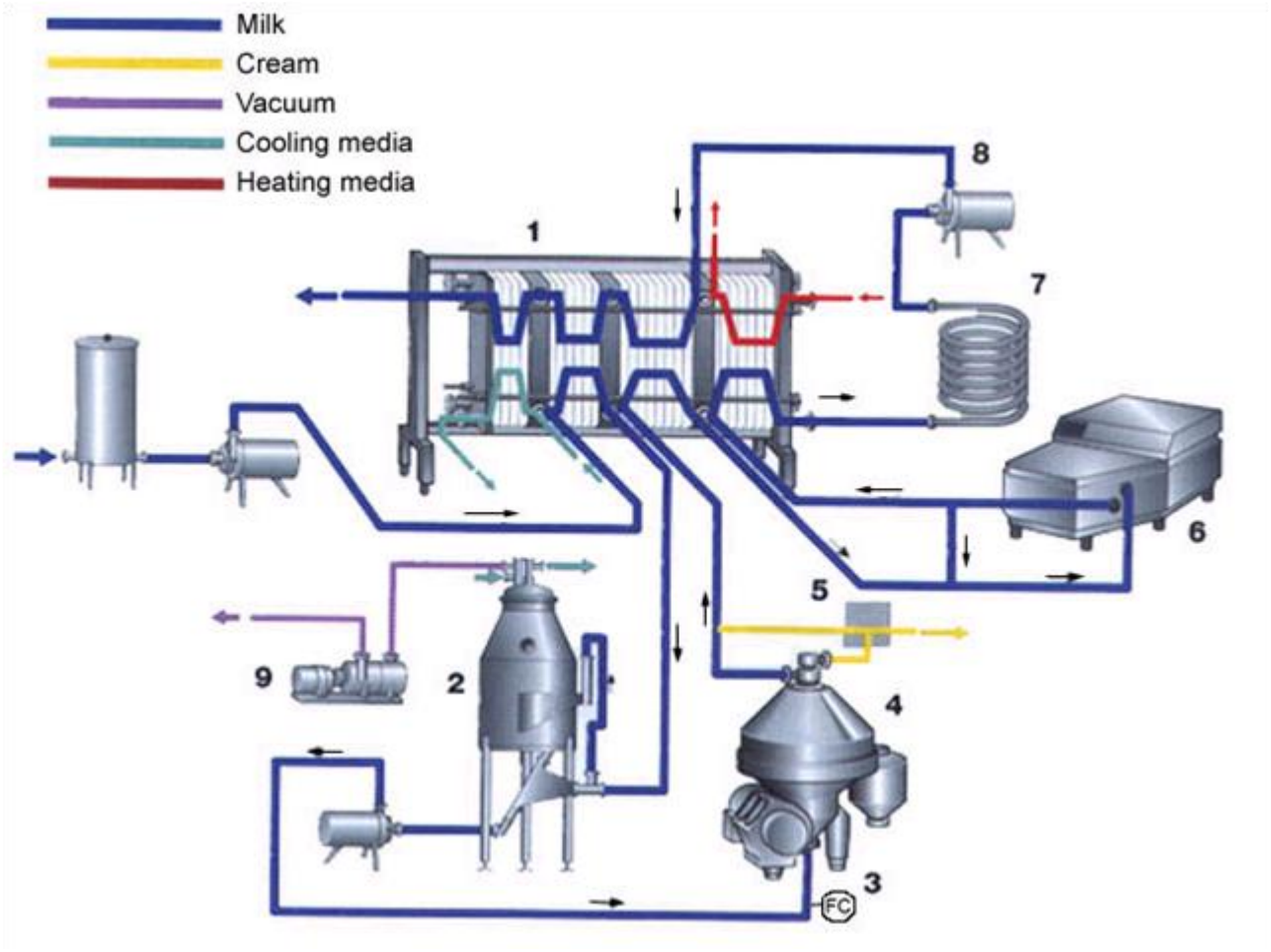
Cleaning/disinfection of equipment



Question 1

What is colostrum?

There are two main types of liquid milk processing used in the dairy industry: High Temperature Short Time (HTST) and Batch processing. An overview of the HTST technology commonly used in dairy products manufacture is shown below.



1 Heat exchanger

2 De-aerator

3 Flow controller

4 Separator

5 Standardisation unit

6 Homogeniser

7 Holding tube

8 Centrifugal booster pump

9 Vacuum pump

Whilst the above arrangement is commonly found in liquid milk pasteurising dairies, variations will be found in manufacturers of other dairy products.

Question 2

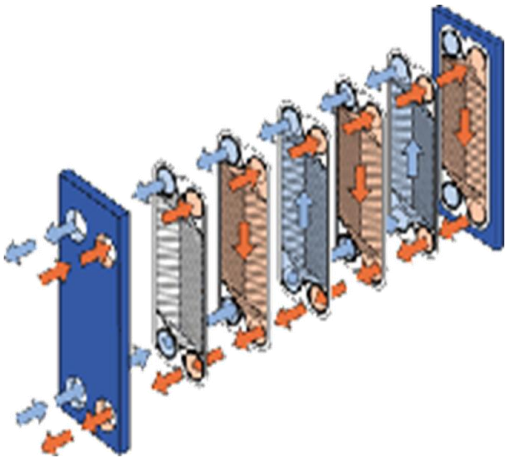
What is the purpose of the holding tube in an HTST pasteuriser plant?

Section 2 - Heat exchangers

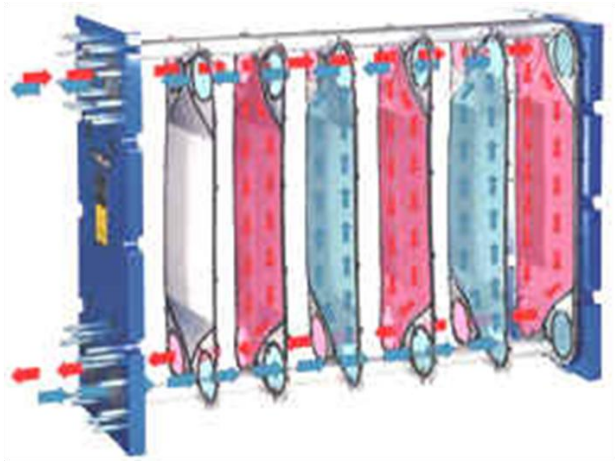
Plate Heat Exchangers are used throughout the food industry and work by continually transferring heat from one liquid medium to another. It is an indirect heat treatment method and relies on the physical separation of the media by a series of thin metal plates.

Heat exchangers are commonly used to cool milk on farms and on reception at the processing dairy; to heat milk to pasteurisation temperatures; to cool milk post pasteurisation and to heat detergents for cleaning in place systems (CIP). The equipment comprises two metal plates connected by steel rods with a series of thin stainless steel plates sandwiched in between.

The liquid to be heated or cooled is passed through portholes in the end plates and allowed to flow in between the stainless steel plates with the heating or cooling media flowing on the other side of the plate. The plates themselves contain rubber gaskets around their circumference and also around the portholes. These gaskets prevent the milk from leaking from the plates and also allow different liquids to be separated within the pasteuriser itself.



In the above diagram, cold raw milk (blue) enters the heat exchanger (pasteuriser) through the bottom left port hole, hot water (red) enters via the top right porthole. The water and milk flow on opposite sides of the metal plates allowing heat transfer to occur between them. In dairy heat exchangers, common coolants include chilled water or food grade glycol.



Heat exchangers are pressurised systems and there is significant potential for cross contamination between the media to occur should pinholes develop in the plates. As such the integrity of the pasteuriser plates is critical to the safe processing of milk.

It is important that the dairy undertake periodic checks of the plates to check for pin holes, deposits, corrosion and the condition of gaskets. The frequency of such checks is largely dependent on use.

The most important part of a milk pasteuriser is the regeneration section. Here, cold raw milk can be found on one side of the pasteuriser plates with hot pasteurised milk on the other. The raw milk is preheated by the pasteurised milk which as a consequence is cooled. In order to prevent cross contamination, the pasteurised milk is placed under higher pressure that the raw. If there were a breach of the pasteuriser plate, the pasteurised milk will therefore spray into the raw milk and not the other way round.

Question 3

What are the disadvantages of plate pack pressure testing?

Section 3 - Pasteurisation plant

There are two main types of pasteurisation process used within the dairy industry: High Temperature, Short Time (HTST) continuous process; and batch pasteurisation.

HTST Pasteurisation

HTST plants can be set up to run manually, automatically or semi automatically. Most on-farm dairies will operate manual systems whereas large modern dairies will use automatic systems for their main products but may also operate manual and/or semi-automatic systems for low throughput products. As discussed in section 1, the HTST plant may include the following components:

Balance bowl

Heat exchanger (pasteuriser)

Holding tube

Divert valve

Raw milk enters the balance bowl and then is pumped into the regeneration section of the pasteuriser. Once thermised, the milk may be directed into a separator and/or homogeniser and may be returned to the regeneration section of the pasteuriser between these operations.

The milk then flows into the heated section of the pasteuriser where it is heated to the desired temperature. The milk is held at this temperature by passing through a stainless steel holding tube of known length and diameter at the end of which there is a temerature sensor and diversion valve. If the milk is at the desired temperature when it reaches the end of the holding tube, the diversion valve directs it into the cooling section of the pasteuriser before passing out of the pasteuriser via the cooler exit into storage tanks or directly into containers. Where the milk fails to meet the desired temperature at the end of the holding tube, the divert valve directs it back to the balance bowl and the pasteuriser enters "recirculation".

Question 4

At what temperature should a liquid drinking milk HTST pasteuriser divert valve be set to operate at?

Pasteuriser operation

Manual pasteurisers are normally started up at the beginning of a production run using water pumped into the plant via the balance bowl rather than milk. The start up procedure will vary depending on the type of equipment in use but will normally follow these main steps:

1. Water introduced into the system

2. Steam valves turned on to heated section of the pasteuriser

3. Water allowed to circulate at sterilisation temperature

4. Water temperature reduced to pasteurisation temperature

5. Operation of the divert valve checked

6. Cooling section of pasteuriser turned on

7. Milk introduced into pasteuriser

8. Extraneous "interface water" drained from pasteuriser

9. Pasteuriser placed into forward flow.

Question 5

How should the operation of the divert valve be checked?

Thermograph charts

The following matters are normally recorded by a thermograph unit attached to the pasteuriser:

1. The temperature of the milk at the end of the holding tube.

2. The temperature of the milk at the cooler exit.

3. The status of the divert valve.

Question 6

Download a thermograph chart and answer the following questions:

1. What time did the milk production start?

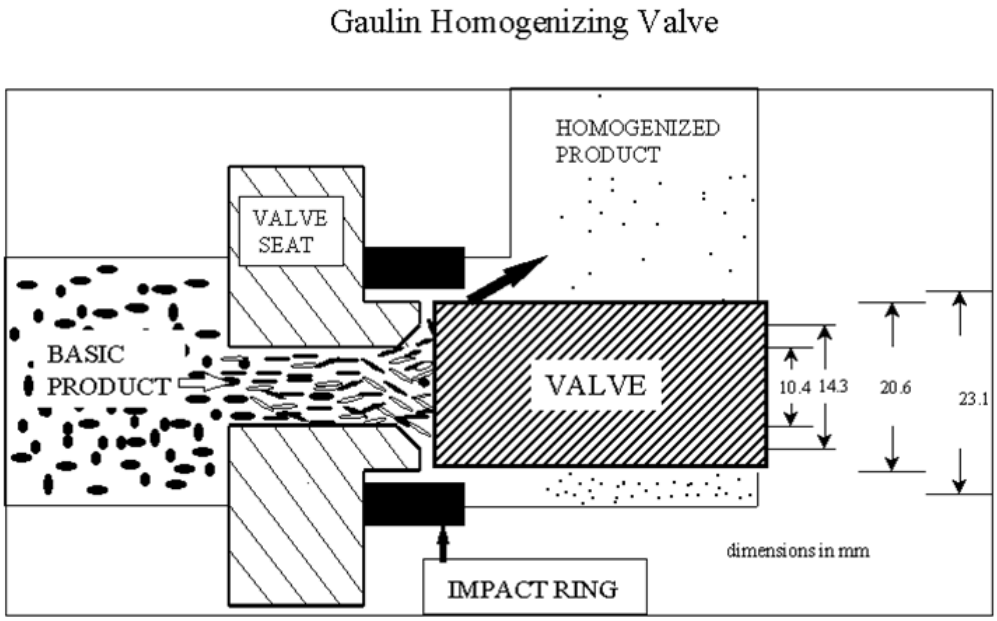
2. What time did the milk production end?

3. What concerns are there regarding this chart?

Your notes:

Section 4 - Homogenisation

Homogenisation breaks down the fat globules in milk and forms a homogenous solution where no cream line forms when the milk is allowed to stand. Homogenisation is achieved by forcing the milk through a tiny aperture formed between an impact ring and valve under pressure:



It is common practice for two-stage homogenisation to be used.

Question 7

What is the purpose of homogenisation?

Your notes:

Section 5 - Separation

Whole (full fat) milk can be separated into cream and skimmed milk by the application of centrifugal force. This is achieved by feeding the milk into a series of spinning conical disks in a separator. There are a variety of techniques that can be used. which may result in the formation of cream of a specific fat content. However, it is now common practice in dairies to separate all incoming milk and then re-blend it to produce milk of the desired fat content.

The separation process is more efficient with hot milk and is often undertaken at thermised temperatures and is achieved by passing the milk between a series of spinning concentric cones. Skimmed milk is more dense than cream and therefore moves to the outside of the spinning cones whereas the cream is retained in the centre.

During the inspection of a dairy, it is important to determine whether the separator is also being used as a clarifier. In modern, computer controlled dairies this is often the case and raises no significant food safety concerns. However, in smaller and on-farm dairies, the use of separators as clarifiers means that the same piece of equipment is being used to process both raw and pasteurised milk and as such the contamination risks are real if not properly managed.

Question 8

What is a clarifier?

Section 6 - Glass bottle production

There are very few glass bottle producing dairies still in production in the UK, with most dairies now catering exclusively to the supermarket sector. However, some customers prefer to have milk delivered to their doorstep in traditional bottles and so there is still a niche market for this sector. The main stages in the production of milk in glass bottles are:

Reception of returned empty bottles

De-crating

Bottle washing

Scanning of washed bottles

Filling of bottles

Re-crating

Question 9

What can be the consequences of mis-aligned jet bars in a hydrojet bottle washer?

Section 7 - Carton production

The vast majority of liquid milk production in the UK is for the retail market, particularly supermarkets, in non-returnable containers. The main containers used for this purpose are:

Cardboard cartons

Polybottles

Portion packs

Polybags

Pergals

Polybottle filling machines

The most common form of polybottle filling machine is the vacuum carousel filler although there are others. The carousel filler works in the same way as glass bottle fillers using the following steps:

1. Pre-formed polybottles are fed into the filling machine

2. The bottles are offered up to rubber filling valves by means of a raised platform

3. A vacuum snorkel is inserted into the bottle

4. The milk is dispensed into the bottle

5. A tamper evident cap is applied

6. The bottle is labelled and date coded

Cardboard carton filling machines

There are several types of carton filling machine but the two most common are the Tetra Pak fresh milk carton filler and the Tetra Brik aseptic carton filler.

Fresh milk carton fillers operate in the following way:

1. Flat cardboard cartons are fed into the machine.

2. The cartons are formed into shape.

3. The bottom of the carton is sealed.

4. The milk is dispensed into the carton.

5. The top of the carton is heat sealed.

6. The carton is date coded.

UHT cartons are filled in aseptic fillers in the following way:

1. The carton material is continuously fed into the machine from a roll.

2. The carton is formed into a long tube and then heat sealed as milk is streamed into it.

3. The resultant brik is date coded.

Section 8 - Other dairy equipment

Cheese vats

Cheese is normally made in cheese vats which can vary in size ranging from bath sized vats to vats that are several metres long. The main components of a cheese vat are shown in the diagram below:

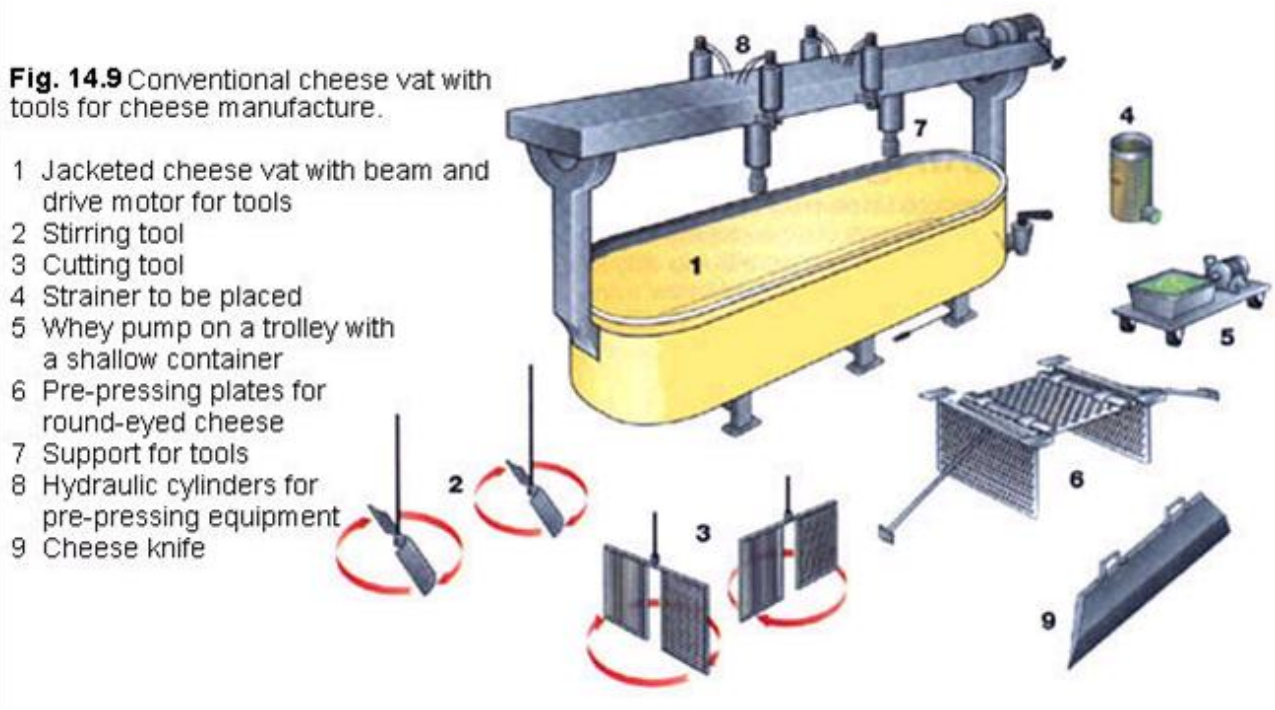


Fig. 14.9 Conventional cheese vat with tools for cheese manufacture.

1 Jacketed cheese vat with beam and drive motor for tools
2 Stirring tool
3 Cutting tool
4 Strainer to be placed
5 Whey pump on a trolley with a shallow container
6 Pre-pressing plates for round-eyed cheese
7 Support for tools
8 Hydraulic cylinders for pre-pressing equipment
9 Cheese knife